

✓  
A2  
end  
(landmarks) whose positions are known in a three-dimensional array are arranged in the real space. Then, the external parameter of the camera is corrected using an error between the actual position of a target landmark, included in some landmarks captured by the camera and displayed on the display screen of the camera, and the position of the target landmark predicted based on the position and orientation of the camera at the time, acquired by a position and orientation sensor.

Please replace the paragraph starting at page 2, line 23, and ending at page 3, line 4, with the following replacement paragraph. A marked-up copy of the paragraph starting at page 2, line 23, and ending at page 3, line 4, showing the changes made thereto, is attached.

A3  
J  
In another method, when there are a plurality of landmarks in the real space, using three (or one or two) landmarks in the image captured by a camera, and a measurement value measured by a position and orientation sensor, a projective matrix from the real space (three-dimensional space) to the display screen (two-dimensional plane) of the camera is calculated by a matrix operation, and an external parameter of the camera is corrected using the obtained matrix.

IN THE CLAIMS:

Please cancel Claim 5 without prejudice to or disclaimer of the recited subject matter.

Please amend Claims 1, 3, and 6-21 as follows. Please add new Claim 24 as follows. A marked-up version showing the amendments to the claims is included in the attached appendix. For the Examiner's convenience, all of the pending claims are presented, regardless of whether the claims is currently being amended.

1. (Amended) A position and orientation determination apparatus which identifies a parameter indicating a position and orientation of a capture unit adapted to capture a picture in a real space containing a plurality of feature points whose positions are known in a three-dimensional array, comprising:

a position and orientation measurement unit adapted to measure the position and orientation of the capture unit in a method other than using a captured picture;

a detection unit adapted to detect the plurality of feature points and their positions in a two-dimensional array on an image pickup screen using the picture in the real space captured by the capture unit;

a prediction unit adapted to predict the positions of the feature points in the two-dimensional array on the image pickup screen based on the position and orientation of the capture unit measured by said position and orientation measurement unit; and

a correction unit adapted to correct a parameter of the measured position and orientation of the capture unit based on the positions of the feature points on the image pickup screen of the capture unit obtained by said prediction unit, and based on the positions of the feature points obtained by said detection unit

2. (Unamended) The position and orientation determination apparatus according to claim 1, wherein an artificially applied marker is used as the plurality of feature points whose three-dimensional positions are known.

Sub D  
3. (Amended) The position and orientation determination apparatus according to claim 1, wherein a point originally existing in the real space as the plurality of feature points whose three-dimensional positions are known, and whose two-dimensional positions can be detected on the image pickup screen by said detection unit.

A5  
4. (Amended) The position and orientation determination apparatus according to claim 1, further comprising:

B  
an image generation unit adapted to generate an image of a virtual object based on the corrected parameter, and to superimpose the image of the virtual object on the picture in the real space captured by the capture unit.

Claim 5 has been cancelled.

Sub D  
Contd  
H 5. (Amended) The position and orientation determination apparatus according to claim 1, wherein said position and orientation measurement unit is a sensor for measuring the position and orientation of the capture unit.

5  
4  
7. (Amended) The position and orientation determination apparatus according to claim 6, wherein said sensor is a magnetic sensor for measuring the three-dimensional position and orientation of the capture unit.

6  
8. (Amended) The position and orientation determination apparatus according to claim 1, wherein said correction unit corrects the parameter such that the capture unit either rotates or translates.

Sub  
D1  
7  
9. (Amended) The position and orientation determination apparatus according to claim 1, wherein said correction unit corrects the parameter of the capture unit by combining rotation transform with translation transform.

8  
10. (Amended) The position and orientation determination apparatus according to claim 9, wherein said correction unit corrects the parameter of the capture unit by combining rotation transform with translation transform alternately and plural times.

9  
11. (Amended) The position and orientation determination apparatus according to claim 9, wherein said correction unit corrects the parameter such that the capture unit can rotate, and then re-predicts the two-dimensional position of the feature point on the image pickup screen based on the position of the feature point in the real space and the position and orientation of the camera after the correction, and the capture unit can translate.

10  
12. (Amended) The position and orientation determination apparatus according to claim 9, wherein said correction unit corrects the parameter such that the capture unit can translate, and then re-predicts the two-dimensional position of the feature point on the image pickup screen based on the position of the feature point in the real space and the position and orientation of the camera after the correction, and the capture unit can rotate.

DI  
89  
cancel  
11  
13. (Amended) The position and orientation determination apparatus according to claim 1, wherein said correction unit computes a first average value on the image pickup screen of the capture unit using the position of the feature point obtained by said prediction unit, and a second average value on the image pickup screen of the capture unit of the feature point detected by said detection unit, and corrects the parameter such that the first average value matches the second average value.

15  
14. (Amended) The position and orientation determination apparatus according to claim 1, wherein said correction unit computes a first average weighting value on the image pickup screen of the capture unit using the position of the feature point obtained by said prediction unit, and a second average weighting value on the image pickup screen of the capture unit, of the feature point detected by said detection unit, and corrects the parameter such that the first average weighting value matches the second average weighting value.

12 ~~15~~

15. (Amended) The position and orientation determination apparatus according to claim ~~13~~<sup>11</sup>, wherein when the parameter of the capture unit is processed plural times alternately by rotation transform and translation transform, said correction unit repeats the process until an average value or an average weighting value of an error between the position of the feature point corrected by said prediction unit and the position of the feature point on the image pickup screen is equal to or less than a predetermined value or until the error cannot be smaller.

16 ~~14~~

16. (Amended) The position and orientation determination apparatus according to claim ~~14~~<sup>15</sup>, wherein when the parameter of the capture unit is processed plural times alternately by rotation transform and translation transform, said correction unit repeats the process until an average value or an average weighting value of an error between the position of the feature point corrected by said prediction unit and the position of the feature point on the image pickup screen is equal to or less than a predetermined value or until the error cannot be smaller.

13 ~~15~~

17. (Amended) The position and orientation determination apparatus according to claim ~~13~~<sup>11</sup>, wherein when said correction unit corrects the parameter such that the capture unit can rotate, the feature point whose position predicted by said prediction unit is associated with the feature point detected by said detection unit, a rotation axis and a rotation angle with which the position of the feature point on the image pickup screen of the capture unit using the position of the feature point obtained by said prediction unit matches the position of the feature point on the image pickup screen of the capture unit

obtained by said detection unit are obtained for each feature point, and the parameter can be corrected by using average values of the rotation axis and the rotation angle obtained for each feature point which is dealt with.

17 ~~16~~

18. (Amended) The position and orientation determination apparatus

~~18~~ 15

according to claim ~~14~~, wherein when said correction unit corrects the parameter such that the capture unit can rotate, the feature point whose position predicted by said prediction unit is associated with the feature point detected by said detection unit, a rotation axis and a rotation angle with which the position of the feature point on the image pickup screen of the capture unit using the position of the feature point obtained by said prediction unit matches the position of the feature point on the image pickup screen of the capture unit obtained by said detection unit are obtained for each feature point which is dealt with, and the parameter can be corrected using average weighting values of the rotation axis and the rotation angle obtained for each feature point which is dealt with.

14 ~~13~~

19. (Amended) The position and orientation determination apparatus

~~13~~

according to claim ~~13~~, wherein when said correction unit corrects the parameter such that the capture unit can translate, the feature point whose position predicted by said prediction unit is associated with the feature point detected by said detection unit, a difference between the position of the feature point obtained by said prediction unit and the position of the feature point obtained by said detection unit is obtained for each feature point which is dealt with, and the parameter can be corrected using average values of the difference obtained for each feature point which is dealt with.

a

21  
AT  
Cont'd

18/20. (Amended) The position and orientation determination apparatus according to claim 14, wherein when said correction unit corrects the parameter such that the capture unit can translate, the feature point whose position predicted by said prediction unit is associated with the feature point detected by said detection unit, a difference between the position of the feature point obtained by said prediction unit and the position of the feature point obtained by said detection unit is obtained for each feature point which is dealt with, and the parameter can be corrected using average weighting values of the difference obtained for each feature point which is dealt with.

21. (Amended) A position and orientation determination apparatus which identifies a parameter indicating a position and orientation of a capture unit adapted to capture a picture in a real space containing a plurality of feature points whose positions are known in a three-dimensional array, comprising:

a position and orientation measurement unit adapted to measure the position and orientation of the capture unit in a method other than using a captured picture;

a detection unit adapted to detect the plurality of feature points and their positions in a two-dimensional array on an image pickup screen using the picture in the real space captured by the capture unit;

a prediction unit adapted to predict the positions of the feature points in the two-dimensional array on the image pickup screen based on the position and orientation of the capture unit measured by said position and orientation measurement unit; and

a correction unit adapted to correct a parameter of the measured position and orientation of the capture unit based on the positions of the feature points on the image



97 and  
pickup screen of the capture unit obtained by said prediction unit, and based on the positions of the feature points obtained by said detection unit.

---

22. (Unamended) The program code which performs the position and orientation determining method according to claim 21.

23. (Unamended) The storage medium storing the program code according to claim 22.

Please add new Claim 24 as follows:

19 21  
Sub 98  
24. (New) An information processing method comprising the steps of:  
acquiring a measurement result obtained by a sensor which measures a position and orientation of a capture unit, <sup>the capture unit</sup>  
detecting a plurality of landmarks from an image captured by the capture unit,  
generating a viewing transform condition based on the measurement result,  
generating a correction condition using the plurality of landmarks detected in said detecting step,  
generating a virtual image based on the viewing transform condition and the correction condition, and  
combining the generated virtual image and the captured image.--

---